Appendix 6

Freshwater Ecosystems Scoping Workshop Summary

Freshwater Ecosystems Scoping Workshop
National Park Service Arctic Network Inventory and Monitoring Program

June 2–4, 2004

Springhill Suites, Fairbanks, Alaska

Purpose of the Workshop

The purpose of this workshop is to provide a forum for NPS resource managers and scientists to discuss ideas for building a statistically sound, ecologically based, management-relevant, and affordable monitoring program for the Arctic Network (ARCN) of parks. The information gleaned from this Freshwater Workshop will be used to form the basis for drafting a long-term monitoring plan for the Arctic Network. All sections of this notebook are in draft form and will be revised after input from participants is received.

Objectives for the Scoping Workshop

1. Review and discuss conceptual modeling effort
2. Identify specific monitoring questions for freshwater ecosystems
3. Identify possible sampling methodologies for high-priority monitoring questions

Arctic Network, National Park Service
Freshwater Monitoring – Scoping Workshop

Agenda

June 2, 3, and 4, 2004

Fairbanks, Alaska – Springhill Suites Hotel

Objectives for the Scoping Workshop

1. Review conceptual ecosystem models and general monitoring framework
2. Develop working groups' highest priority candidate questions for freshwater monitoring
3. Identify suggestions for sampling methodologies for highest priority monitoring questions

Wednesday, 2 June

4:00 Arrival and refreshments

4:30 Discussion of preliminary notebook materials: participants are asked to make informal comments on the notebook. See worksheet A (page 9).

5:30 Adjourn for dinner

6:00 Gather for dinner at Gambardella's Pasta Bella, 706 Second Avenue

Arctic Network, National Park Service
Freshwater Monitoring – Scoping Workshop

Agenda

Thursday, 3 June

Objectives for Day Two

1. Discuss/review conceptual ecosystem model
2. Working Groups develop comprehensive list of monitoring questions

8:00	Arrival and Continental Breakfast
8:30	Introductions
	Welcome: Dave Mills
	Review of Agenda: April Crosby, Meeting Facilitator
	Inventory and Monitoring Program: Sara Wesser
	Overview of the Arctic Network: Diane Sanzone
9:30	Overview of the Arctic Parks: Jim Lawler
10:00	BREAK
10:20	Overview of Aquatics in the Parks: Amy Larsen and Diane Sanzone
10:50	Aquatic Sampling for Western Airborne Contaminants Assessment Project: Dixon Landers
11:10	Framework for Conceptual Model Development: Steve Young
11:40	Discussion and Suggestions for Conceptual Models
12:30	LUNCH
1:30	Instructions to Working Groups
1:45	Working Groups: Each working group will develop a comprehensive list of potential monitoring questions, organized by sections on Worksheet B (see page 11). The groups need not prioritize your questions at this point. A recorder for each group must type the questions into the electronic worksheet provided on the laptop, and be prepared to review questions with the whole group.
3:30	BREAK
3:50	Reports from Working Groups
4:45	Review Question Set for Omissions, Duplication, etc.
5:00	Adjourn for dinner
6:00	Out of town participants gather at Pike's Landing for dinner, 4438 Airport Way

Arctic Network, National Park Service
Freshwater Monitoring – Scoping Workshop

Agenda

Friday, 4 June

Objectives for Day Three

1. From yesterday's list, identify top 10 priority questions for monitoring
2. Develop initial suggestions for monitoring design for highest priority questions

8:00	Arrival and Continental Breakfast
8:30	Review and Revise Agenda
8:35	Working Groups: Develop from the list of monitoring questions the 10 highest priority candidates for monitoring. See Worksheet C, page 13. Identify these candidates on the electronic worksheets provided and write each of the top-priority candidates on a page of flip chart paper (for eventual use by the whole group).
10:15	BREAK
10:35	Reports from Working Groups on monitoring priorities
11:30	Large group discussion: Are we missing any of the key ecosystem components or anthropogenic stressors?
12:00	LUNCH
1:00	Watershed approach to monitoring: Diane Sanzone
1:15	Large group discussion: For the second part of this discussion, the whole group will identify the overall top 10 highest priority monitoring questions from the previous work group discussions. Comments on the remaining questions will be noted.
2:30	BREAK
2:50	Large group discussion continues: Suggestions for study design for the 10 priority questions identified by the large group.
4:15	Reflection on the workshop and participants' suggestions for the network monitoring program
4:30	Adjourn

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ARCN Draft Monitoring Objectives for Freshwater Ecosystems

Objective 1: Collect baseline data on the physical, chemical, and biological parameters of streams, lakes, wetlands, and surrounding watersheds within the ARCN.

Objective 2: Determine long-term trends in the physical, chemical, and biological characteristics of streams, lakes, wetlands, and surrounding watersheds within ARCN.

Objective 3: Understand how landscape components interact at various spatial and temporal scales to affect freshwater ecosystems.

Freshwater Resources of ARCN

The ARCN parks have an extensive and diverse array of freshwater ecosystems that are relatively undisturbed by human activity. Key features of the landscape are the large freshwater lakes, seemingly endless miles of river networks, large expanses of wetlands, and unique isolated spring systems. There are seven wild and scenic rivers in the ARCN, including the Noatak, Salmon, Kobuk, Alatna, John, Tinayguk, and North Fork of the Koyukuk. All of the rivers of the ARCN are free-flowing and run clear most of the year. There are a few glacial streams that originate in the Brooks Range and several spring streams, including tributaries of the Reed River, Kugrak River, and Alatna River, although to date little or no studies have been conducted on them.

Much of the land within the ARCN is drained by streams that flow from the uplands into lowland areas, then empty into the Chukchi Sea or coastal lagoons. These lagoons have been a primary fishing ground for Native populations for the past 9,000 years. During the ice-free season, some of these streams and associated coastal lagoons provide important habitat for anadromous and freshwater fish populations, birds, and terrestrial mammals.

There are many lakes in the ARCN. Many of the large deep lakes such as Chandler, Selby, Feniak, and Matcharak are renowned for their fisheries resources. These sites are heavily used by both subsistence and sport fishers. One of the largest, Walker Lake, was designated a national natural landmark in April 1968. Thousands of shallow lakes and wetlands are distributed throughout the parks. These ecosystems have diverse geologic origin, including countless thaw ponds, kettle lakes, maars and oxbows that provide important rearing areas for fish, macroinvertebrates, and waterfowl. There is little or no information on groundwater in these parks, although some larger geothermal systems have been studied (e.g., Serpentine Hot Springs).

Specific Monitoring Questions and Potential Monitoring Components (Vital Signs) for Freshwater Ecosystems of the Arctic Network

I. Streams Working Group

Question 1: How do we monitor change in flow and temperature regimes to document annual hydrologic patterns in streams? (number of votes= 8; rank= 2)

Attribute (Component/Process): stream temperature, stream flow and discharge
Potential Driver/Stressor of Change: climate change, warming trend (all aspects)
Potential Driver/Stressor of Change: various

Question 2: What is the location and distribution of spring ecosystems (groundwater upwelling areas) in ARCN? What is the amount of ice deposition due to these upwelling areas? What is the importance of springs to fish as spawing and overwintering habitat? (number of votes= 8; rank= 2)

Attribute (Component/Process): document location of springs and groundwater upwelling areas, flow dynamics of springs, distribution of fish in relation to spring areas
Potential Driver/Stressor of Change: change in flow dynamics and hydrology due to changes in the hydrologic cycle
Potential Driver/Stressor of Change: various

Question 3: Are there significant shifts in biodiversity or ecosystem processes in streams due to global warming? (number of votes= 12; rank= 1)

Attribute (Component/Process): stream invertebrates, fish, changes in stream foodwebs
Potential Driver/Stressor of Change: various

Question 4: What changes in water chemistry are occurring? What is its influence on primary productivity? (number of votes= 8; rank= 2)

Attribute (Component/Process): pH, turbidity, nitrogen, phosphorus, chlorophyll, algal and plant biomass
Potential Driver/Stressor of Change: various

Question 5: How are spawning sheefish (*Stendous leucichthys nelma* [Pallas]), also known locally as *inconnu*, populations changing due to past and current harvest practices? (not voted on; rank= 5)

Attribute (Component/Process): sheefish population
Potential Driver/Stressor of Change: overharvest of species, possible presence of exotic species, nutrient and contaminent loading
Potential Measures of Change: fish tissue for detecting change in loads (sheefish are a good indicator species); visitor use surveys to detect change in harvest patterns

Question 6: Are sediment dynamics changing? (number of votes= 7; rank= 3)

Attribute (Component/Process): stream substrate composition, channel morphology; and streambed characteristics
Potential Measures of Change: fine sediment loads and sediment dynamics, pebble counts, remote sensing of lakes and streams, glacier and snowfield monitoring

Question 7: How will the distribution of marine-derived nutrients change over time? Will there be a decrease in marine-derived nutrients moving upstream? How will instream foodwebs upstream be affected? Riparian species? Upland species? (number of votes= 8; rank= 2)

Attribute (Component/Process): marine-derived nutrients (N, C, Si)

Potential Driver/Stressor of Change: warming trend, overharvest of anadromous fish

Potential Measures of Change: change in marine-derived nutrients in nonmobile instream species/communities (benthic macroarthropods, slimy sculpin); change in riparian and upland species (alder, terrestrial macroarthropods, birds, predatory mammals)

Question 8: What is the water quality currently downstream from villages? From the Red Dog Mine? How is water quality in this use area changing over time? Are any wild and scenic rivers being impacted downstream? (number of votes= 8; rank= 2)

Attribute (Component/Process): water quality in and around areas influenced by industrial and human development, natural vs. anthropogenic inputs of minerals to waterbodies

Potential Driver/Stressor of Change: local villages, mines (especially streams near Red Dog Mine and in the Maryumerak Mountains), recreational visitors

Potential Measures: nutrients, fecal coliform

Questions 9: What are the long-term changes in riparian communities along river corridors and what is the effect of those changes on stream communities and ecosystem function? (number of votes= 5; rank= 4)

Attribute (Component/Process): changes in vertebrates (mammals and birds), invertebrates and vegetation in the riparian zone

Potential Driver/Stressor of Change: various

Potential Measures: should monitor riparian vegetation using remote sensing (e.g., satellite imagery or aerial photos), should have photographic documentation of these areas

Question 10: What are the charasmatic megafauna of the major drainages? What are the most important ecological components for the public or local population? (number of votes= 8; rank= 2)

Attribute (Component/Process): Noatak and Kobuk River biota and habitat

Potential Driver/Stressor of Change: local subsistence or sports fisheries

Potential Measures: inventory and classification of streams and rivers and associated biota is needed

Question 11: Could invertebrates be used as indicators of stream condition? How are invertebrates changing along a longitudinal gradient? (number of votes= 12; rank= 1)

Attribute (Component/Process): stream invertebrates (invertebrates as indicators of stream condition, change in invertebrates along a longitudinal gradient, invertebrate diversity, abundance, biomass and functional groups); macroinvertebrate community indices, e.g., RIVPACS (River Invertebrate Prediction and Classification System), EPA Rapid Bioassessment Protocols, IBI

Potential Driver/Stressor of Change: various

II. Lakes Working Group

Question 1: How will expected climate change affect the ecosystem of lakes? How do hydrogeomorphic changes affect hydrology? (number of votes= 8; rank= 2)

Attribute (Component/Process): assessment of impact of arctic climate change

Potential Driver/Stressor of Change: climate, thawing of permafrost, extension of growing season, modification of habitat availability, changes in precipitation, disturbance, loss of glaciers

Potential Measures: (1) slumping of lake shorelines: additions of organic matter, changes in nutrient concentrations; (2) lake drying; (3) extension of growing season; (4) warming of lakes: changes in organism life histories (growth rates, reproductive success) or diversity, potential for exotic species introductions and establishment, changes in timing of ice off, increase in parasitism, shifts in range extensions, changes in nutrient cycles associated with warming, changes in range extensions due to changes in habitat availability because of modifications in timing and extent of ice thickness, changes in thermal stratification in lakes, changes in spawning periodicity; (5) treeline changes: changes in riparian corridor, changes in light environment due to CDOM from shifts in riparian tree species, changes in fire regime and the cascading effects on nutrient regime, changes in sediment loads; (6) potential changes in precipitation, water residence time, lake level, and associated changes; and (7) long-term survival of lakes: physical/chemical changes, disturbance regime, especially disturbance to sea level rise, storm surges, sedimentation, salinization, lake stratification changes, loss of glaciers, changes to turbidity, changes in total dissolved solids

Question 2: How do changes in inputs of nutrients affect the biota and productivity of lake ecosystems? How do changes in the nutrient regime in lakes affect the structure and function of resident biota? (note: we understand that these are process-related questions that need to be rephrased for monitoring) (number of votes= 8; rank= 2)

Attribute (Component/Process): eutrophication (enrichment and change in biota and processes caused by increased loading of nutrients)

Potential Driver/Stressor of Change: atmospheric inputs, local human settlements, increased weathering due to soil warming and roads and infrastructure development

Measures: S, N, and C stable isotope ratios, changes in acidity and alkalinity

Question 3: What are the impacts of consumptive use on lotic and lentic ecosystems? (number of votes= 8; rank= 2)

Attribute (Component/Process): consumptive harvest of fish and waterfowl

Potential Driver/Stressor of Change: consumptive use (e.g., resource harvest of fish and waterfowl, potential food web effects, lead shot, alteration in fish growth)

Measure: visitor use surveys

Question 4: Are contaminants present and in what ecosystem compartments (biotic or abiotic)? What are the sources and pathways of contaminants? (number of votes= 8; rank= 2)

Attribute (Component/Process): contaminants, specifically: (1) metals: mercury, lead, cadmium, nickel etc; (2) organic compounds: persistent organic pollutants (POPs) and semivolatile organic compounds (SOCs); bioaccumulation of all contaminants; (3) acidic precursors: nitrogen/sulphur; (3) natural versus anthropogenic sources

Potential Driver/Stressor of Change: global and local sources (i.e., mining activities, oil and gas development)

Potential Measures: establish baseline and spatial distribution of contaminants in water, snow, sediments, fish, and macroinvertebrates using spectrographic analysis, determine impacts on populations, contaminant loads in organisms; look at changes in life histories and sex ratios

Question 5: What is the diversity and species composition in Arctic Network lakes and streams? (number of votes= 12; rank= 1)

Attribute (Component/Process): biodiversity of organisms in lakes and streams (entire community, all groups)

Potential Driver/Stressor of Change: various

Potential Measures: inventory species composition and relationship to community interactions and ecosystem function, functional group classification, invertebrate and fish community indices (e.g., RIVPACS), zooplankton, and vegetation diversity

Question 6: How are the physical and chemical constituents of lake ecosystems changing? (number of votes= 8; rank= 2)

Attribute (Component/Process): chemical and physical processes in lakes

Potential Driver/Stressor of Change: various

Potential Measures: alkalinity, conductivity, pH, organic matter, light regime (during open water and winter seasons), turbidity, changes in autotrophic vs. heterotrophic processes

Question 7: How do local plant and animal populations affect the nutrient regimes in lotic systems? How are terrestrial inputs to aquatic ecosystems changing? How are aquatic inputs to terrestrial ecosystems changing? (not voted on; rank= 5)

Attribute (Component/Process): terrestrial inputs to aquatic ecosystems, aquatic inputs to terrestrial systems

Potential Driver/Stressor of Change: various

Potential Measures: waterfowl concentrations, nutrient inputs (Nitrate, DON), carbon

Question 8: What changes can we detect by studying lake sediments? (not voted on; rank= 5)

Attribute (Component/Process): paleo-trajectory

Potential Driver/Stressor of Change: multiple drivers

Potential Measures: diatoms, pigments, cladoceran remains, fish scales, ostracod RNA, nutrients

III. Watershed Dynamics Working Group

Question 1: Stream, river, lake, and wetland inventories and classifications need to be done in these remote parks where we have little background data. (number of votes= 9; rank= 1)

Attribute (Component/Process): stream, river, lake, and wetland inventories and classifications; surface age, underlying geology, surficial geology, soils, and physiography; invertebrates; fish; life history of fishes (e.g., migration, overwintering, spawning and rearing of).

Potential Driver/Stressor of Change: various

Potential Measures: Need basic DEMs and catalog of remote sensed data, expand knowledge base in areas of interest

Question 2: To what degree are snowfields and glaciers changing? (number of votes= 5; rank= 4)

Attribute (Component/Process): extent of snowfields and glaciers

Potential Driver/Stressor of Change: climate change, temperature variation, precipitation, cloud cover, albedo, particulates in the air causing increased warming

Potential Measures: inventory and classification of snowfields and glaciers using remotely sensed data, glacier coring for long-term climate record

Question 3: Are valley and channel morphology changing (including solifluction)? (number of votes= 7; rank= 3)

Attribute (Component/Process): erosion of river banks

Potential Driver/Stressor of Change: milder winters may result in less freezing of ground resulting in an increase in erosion due to greater runoff, warming climate, increased storminess (intensity and duration), increased precipitation (particularly snow), and increased climatic variation

Question 4: Is the duration and thickness of ice changing? (not voted on; rank= 5)

Attribute (Component/Process): changes in ice thickness over time in both lakes and rivers

Potential Driver/Stressor of Change: climate change

Potential Measures: changes in depth and thickness of snow pack, insulation

Question 5: Are the volume and distribution patterns of standing water changing? (not voted on; rank= 5)

Attribute (Component/Process): pond and lake drying, change in volume (depth), size and shape of lakes and ponds

Potential Driver/Stressor of Change: climate change, frequency of flooding, changes in precipitation patterns

Potential Measures: size and shape of lake: changes in size and shapes of lakes could be due to catastrophic events (breaching), thermokarst formation, permafrost collapse, evaporation of water or changes in frequency of water recharge

Question 6: Is flood frequency and extent changing? (not voted on; rank= 5)

Attribute (Component/Process): flooding

Potential Driver/Stressor of Change: increased storminess, ice jams, changes in permafrost changes, long-term changes in vegetative cover

Potential Measures: glacier coring to determine long-term climate record

Question 7: Are changes in land cover and vegetation composition occurring? How are changes in land cover and vegetation composition effecting aquatic ecosystems? (number of votes= 6; rank= 3)

Attribute (Component/Process): Spatial and temporal variability in landcover and various related indices (e.g., NDVI), detailed changes in the plant species composition (biodiversity and changes in species composition); riparian zone vegetation changes; unique features of the landscape

Potential Driver/Stressor of Change: changes in hydrography, active layer melting, surface drying, changes in fire regimes, changes in annual climate variability, human use of the landscape (including hunting and subsistence activity), changes in animal distribution and abundance (beaver, caribou, geese etc.) that alter vegetation

Potential Measures: remote sensed data of vegetation and various other attributes of the landscape, changes in watershed chemistry

Question 8: Has the composition of stream beds changed over time due to changes in physical characteristics of streams? (number of votes= 7; rank= 3)

Attribute (Component/Process): pebble counts

Potential Driver/Stressor of Change: changes in flow regime, geomorphological changes, glacial disappearance, mining history

Question 9: Could macroinvertebrates be used as indicators of stream and lake condition? (number of votes= 12; rank= 1)

Attribute (Component/Process): stream invertebrates

Potential Driver/Stressor of Change: various

Question 10: How is the counter flux of energy, nutrients, and organisms changing due to the cumulative impacts of global warming? (not voted on; rank= 5)

Attribute (Component/Process): changes in aquatic invertebrate emergence, change in anadromous fish movement upstream, near-stream productivity, flux of aquatic-derived nutrients and energy into upland areas via invertebrate predators, birds, and mammals.

Potential Driver/Stressor of Change: climate change
Potential Measures: stable isotope analysis, fatty acid analysis

Question 11: How is water quality changing in rivers and lakes of ARCN? (number of votes= 8; rank= 2)
Attribute (Component/Process): various water quality measurements
Potential Driver/Stressor of Change: glacial melt, landcover changes, anthropogenic disturbance regime, prevailing winds, extent of wetlands in watershed, vegetation characteristics and composition, presence of arctic haze due to cumulative anthropogenic stressors
Potential Measures: water quality measurements such as nitrogen, carbon, contaminants, dissolved oxygen, total suspended solids, water clarity

Question 12: Is the extent and distribution of thermokarsts increasing due to the increased warming trend in the Arctic? How are changes in permafrost and increased thawing (increases in the size of the active layer) due to the current warming trend and related changes in precipitation (rain and snow) affecting hydrologic networks in ARCN? (number of votes= 5; rank= 4)
Attribute (Component/Process): greater extent of thawing and slumping into rivers and lakes, measure permafrost characteristics (depth to thaw, extent and thickness of active layer) in areas of thermokarst formation, amount and timing of precipitation (snow and rain)
Potential Driver/Stressor of Change: climate change, changes in landcover, fire regimes, snow thickness, extent and duration, hydrology, and various other disturbances
Potential Measures: soil type, measurements of fixed physical disturbance caused by natural or anthropogenic means

Question 13: How is climate in ARCN changing? How are precipitation regimes changing over time? How are aquatic ecosystems being effected? (number of votes= 5; rank= 4)
Attribute (Component/Process): timing and extent of precipitation, amount of precipitation as snow and rain, timing of break-up and snow melt, soil moisture, fire, depth of thaw, permafrost, cloud cover, soil temperature and albedo, mass balance
Potential Driver/Stressor of Change: climate change
Potential Measures: timing and intensity of precipitation, historic records of freeze-up events (shipping and barge records on major rivers), radar for snowpack monitoring, past climate records of vegetation (tree cores, chronological sequences), lake cores for diatoms and pollen grains, glacier coring, and mass balance studies

Question 14: What is the location and distribution of spring ecosystems (groundwater upwelling areas) in ARCN? What is the amount of ice deposition due to these upwelling areas? (number of votes= 8; rank= 2)
Attribute (Component/Process): document location of springs and groundwater upwelling areas, flow dynamics of springs
Potential Driver/Stressor of Change: change in flow dynamics and hydrology due to changes in the hydrologic cycle
Potential Driver/Stressor of Change: spring abundance and distribution, volume of water, aufeis distribution using remote sensed data

Question 15: How are the status and trajectory of landscape-level water resources changing due to climate change and anthropogenic inputs? Are key components of the lake and stream network changing? (number of votes= 8; rank= 2)

Attribute (Component/Process): connectivity, snow fields, drainage patterns (e.g., presence of water tracks), permafrost, bank erosion or deposition, fluvial geomorphology

Potential Driver/Stressor of Change: change in flow dynamics and hydrology due to changes in climate and the hydrologic cycle

Potential Driver/Stressor of Change: cross channel profile, aerial photography, thermokarst measurements, and presence of debris in rivers

Additional Discussion Material

Day I—Wednesday June 2, 2004

April Crosby opened a general discussion, using Worksheet A, to gather big-picture ideas about the proposed monitoring strategy. Did you have any overall thoughts about the material in the notebooks? In thinking about the ARCN specifically, are there specific characteristics or challenges that would define the network from others? Any specific thoughts about the monitoring framework and strategies?

Discussion:

- *Landers: As I read through I thought of the scale looking at comparison with the Lower 48. First thought was how much money do you have to run this? It is a very iterative process, there is a tradeoff between objectives and the money you have. Maybe we should just think just like we could do anything, and just think of the absolute best questions.*
- *Bowden: High quality materials. Scale, remoteness, and complexity are going to be a big challenge. With respect to specific questions on page 9: key steps on page 24 a good process laid out. As a member of the watershed group, I would like to find out what other groups think "watershed monitoring" is, and that should be discussed beforehand.*
- *Crosby: We should allow time to discuss that.*
- *Finn: I've been involved in planning efforts like this before. I think we need to get out in the open what do we really want to know, like pie in the sky stuff, and then look at what is practical. It's good to start with what would be nice to know, and then step back and figure out what/where we can actually go/do.*
- *Crosby: First we'll figure out what is the best science, then later figure out what is practical, as we don't want to stifle anything.*
- *Liebscher: Two parts … logistics and weather challenges. This program is the poster-child of NPS based on deliverables.*
- *Hinzman: I liked the notebook, like the theme. "Watershed monitoring," however, that area is really expensive, and complicated. Must be based on long-term ideals, with long-term analysis, looking at what will change in the next 20 years or more. It is so easy to see what I would have liked to measure 20 years ago. Ice, climate change …*
- *Underwood: You don't have villages on the maps. Don't see much of anthropogenic effects.*
- *Sanzone: Look at the models and other handouts I gave you tonight, and you will see that we have been thinking of those things too.*
- *Luecke: one thing struck me: the emphasis is on the current status, but what are we going to compare these things to? What are the advantages that this program would have? There are some very unique things here.*
- *Young: one of the things you'll hear me harping on is to put this into historic perspective, the business of scale. To emphasize, hindsight, we are in the situation of being without 20 or 50 years of prior data collection, but that we could use paleo data to try and build our hindsight.*
- *Hobbie: Just came in from IARC. Lots of work, just not in the parks.*

- *Hinzman: There is some work that has gone on in the parks from the last 50 years in some lakes and some rivers. It could be used to detect a change, but it would require building a database of what has been done already; would be a high priority.*
- *Liebscher: Incorporation of traditional knowledge, perhaps using that will help define what we should concentrate on to help save money. 21 million acres, it is one of the only places where there are still traditional lifestyles being supported.*
- *Finn: Are these systems models or conceptual models for the monitoring program?*
- *Sanzone: I hope we will glean ideas from this workshop to develop conceptual ecosystem models, starting at very large scales and then more specific ecosystem models.*
- *Young: The idea is to put together the monitoring framework, but the idea here is to put the model of what is going on out there, what scales are going to be the most productive for management, and a broader overall picture in the parks and the Arctic.*
- *Sanzone: As a comparison, the Central and Southwest Alaska networks have both conceptual ecosystem models and models that lay out potential stressors. Those networks took different approaches to creating the models.*
- *Hinzman: Why not just apply those models here? There was already a huge amount of work done?*
- *Young: In these early stages we need to scope out where we are, what might have been missed, how the emphasis might differ, and those other models won't be ignored.*
- *Bowden: interesting discussion. At the simplest, a model is a representation of reality, from stick figures to data-heavy models. I think that high level conceptual models of how these systems work can be highly useful in guiding us, but there is a grey area. It is a huge second step to document the processes and quantify the changes going on. This is a quantum leap. I would caution against large-scale process models; to think about abstract models that could capture change. To capture processes, in a program where the stated goal is to capture status and change, we might get wrapped around the axle to try include process in this.*
- *Luecke: Maybe find biogeochemical indicators of these different processes?*
- *Hobbie: Use organisms as indicators rather than biogeochemical; they are there all year round.*
- *Young: By definition a monitoring program has to grow, as you work you find new and better ways to get better information. We are designing a program that has a process of evolution that should be carried down the road. We are trying to start something that will be growing over the very long-term.*
- *Sanzone: I think the program sees the funding as a base, and that funding will be in flux, that timelines may differ, intervals of sampling will differ. We have quite a bit of time to think about how to set this up, until 2008.*
- *Finn: You think we will have funding until 2007?*
- *Hobbie: Aren't there things that we could measure now, even if we couldn't get back to them in 10 years or so, that would be informative?*
- *Bowden: This is a gargantuan task, but I think we need to go forward with it. The scientist in me wants to get the information about the big process. I am afraid of designing something that is so flexible and large. I don't want to start something that is set up so big that it never comes to fruition.*
- *Liebscher: This funding is designed to ensure a little bit more consistency.*

- *Neitlich: One thing that would help assure funding is to keep things relevant to the parks.*
- *Hobbie: Efficiency is a big question; tying it into previous work. The area has had a lot of freshwater work. It would be a tremendous loss to not take into account the other work. Toolik is site specific, but we need to figure out what general stuff is there to hook into. Also work in Barrow, lakes and ponds work that could be drawn on to see what how things are changing. Some of the stuff we know from the intense process areas we can use to make predictions and test them. I think this region should have a big advantage over other areas, like we are doing with ANWR.*
- *Larsen: Integration on all levels needs to be included with terrestrial and coastal, we need to draw on other research doing process work. If we can somehow narrow in on a central theme it would help drive us over time.*

Day 2—Thursday, June 3, 2004

Dave Mills Welcome:

- Interested in knowing what we don't know and what we ought to know for the long term.
- Parks for preservation of scenery, but we have evolved into more: preserving our country's heritage: natural systems included in this to be passed down to future generations as part of our heritage.
- Parks essentially new in 1980s in Alaska. Late 1980s started to get more serious, with more biology going on.
- Arctic park represents 25% of all national park land-base and are relatively untouched. Still have time to gather good information and make good decisions, the first time.
- This is our opportunity to look bigger/deeper than in the past. Less of a narrow view, not just big mammals and subsistence fish. Give us your advice as to what we should be looking at for more regional and global scales.
- Walter (introduces him) is head of NANA, vice president of north slope . . .
- A lot we can learn from traditional ecological knowledge.
- NPS has evolved as an agency to realize big tasks such as this only work as part of a partnership with universities, local people…
- We are the Yellowstone of 125 years ago. We should have monitored and understood that system so we could protect it. Now we can do it right, here.

Discussion:

- *Sampson: How do we benefit from this as people of the region? We can have this in the back of our minds.*
- *Mills: Hopefully through the course of the two days, that will come up. During this time we are focusing on the freshwater systems, an area of knowledge of how these systems work, which are the lifeblood of the people out there. I think this will help support the people that will be living off the land. We are no longer an isolated region, global industrialization is effecting the arctic environment.*

- *Sampson: With a changing world, the people are changing the way they live. Now we are trying to be proactive; that we are designing a way of life different from the handout system. We want to be independent; will these studies restrict our developments? We want to be able to develop to have sustaining resources to work with. Environmentalist groups are used to fighting against the Native communities.*

Diane Sanzone presented an overview of the NPS I&M Program and the Arctic Network.

Discussion:

- *Sampson: We need to include local knowledge and interests.*
- *Sanzone: We are definitely looking at how to do that.*
- *Sampson: We weren't involved in this from the beginning. But there are more agency people here than local people. Why don't we go to villages and set up a dialog. And include people who depend on these places.*
- *Crosby: Your urgency is clear.*

Jim Lawler presented an overview of the parks.

Discussion:

- *Neitlich: high levels of lead and cadmium throughout the whole park.*
- *Dalle-Molle: These inholdings show how the area is still important. It is not something from just 6,000 years ago. It is still going on today. Also that Red Dog represents the economic development of the region. Very important economically.*
- *Chris: Do the parks end at the coast?*
- *Dalle-Molle: Jurisdiction is to high tide line, but they are mandated to manage for marine mammal habitat.*
- *Lawler: NOAT was made an international biosphere reserve in 1968. A natural baseline against which dynamics of other ecosystems could be compared. A means for maintaining and studying plants and animals.*
- *Luecke: How does setting NOAT aside for science affect us here today?*
- *Liebscher: Suggests its global scale of importance.*
- *Dalle-Molle: For management, the legislation itself set up for scientific guidance, the park just hasn't dealt with it yet.*
- *Bowden: I think its true of all biosphere reserves is not to limit, but to call attention to what could be looked at in a global scale, to encourage science.*
- *Heinlein: I think that we want to implement a legislative mandate that comes from this global designation.*
- *Finn: The Noatak River fisheries subsistence use is hugely important in terms of fish (more than just salmon).*
- *Neitlich: Kobuk Valley's vegetation is a relic of steppes. Dunes are relics of the windy glacial time. Rare or the only ones in the state, in that location.*

- *Bowden: The river is very low gradient throughout the whole park. What is the altitude change from ones side to the other?*
- *Heinlein: Also huge coal deposits on the north.*
- *Liebscher: Northwest NPRA and state leases north of GAAR and other leases all sold. Ice roads, access, and interruption of caribou migration patterns and anthropogenic factors come in there, critical to have the knowledge base.*
- *DeCicco: There are more and more visitor impacts along the Dalton Highway corridor. As well as the gasline development.*
- *Luecke: Is there a plan for a road into Gates from the Dalton into GAAR?*
- *Lawler: Well, maybe for inholdings. Potential to cut off the Castle Mountain areas.*
- *Shults: Look at page 69 for potential roads/RS2477 areas.*
- *Liebscher: There are a small amount of recreational uses. But there are inholdings, and there are state resource extraction things that would be for increased access.*
- *Dalle-Molle: RS2477 are rights of way that predate the parks.*
- *Liebscher: The very undefined idea is the that of navigability. It will be a while before the courts decide on that.*

Amy Larsen presented an overview of the freshwater ecosystems of ARCN:

- I want to show all the historic and Native use sites and how they are all centered on the rivers, the aquatic resources.
- There has been a lot of research done, but nothing is tied together; it's very patchy.

Discussion:

- *Hinzman: How many of these [rivers] are gauged?*
- *Neitlich: The springs are very hard to find, and sometimes they wash out, sometimes they are gone.*
- *Sanzone: There could be a concerted effort to find them, with remote sensing?*
- *Hinzman: we are looking at and visiting most of the springs for the next four years through an NSF grant.*
- *Larsen: 50% of the birds are aquatic/riparian.*
- *Liebscher: Results from harvest surveys for upper Kobuk show one third of diet is from caribou. __is from whitefish.*
- *Larsen: NOAT six physiographic regions.*
- *Sampson: Those 37 "unnamed" streams all have names to them, you know.*
- *Larsen: Sorry, I didn't mean to offend.*
- *DeCicco: What you are calling arctic char are really dolly varden [char].*
- *Bowden: Is the Kobuk clear?*

- *DeCicco: No it is brown…. Stained. But low sediment.*
- *Luecke: The lagoons are mostly freshwater?*
- *Larsen: Brackish. They have very interesting hydrologic cycles. Many streams freeze to the bottom and springs form huge sheets of aufeis. Lagoon salinity can shift dramatically from year to year to season.*
- *Dalle-Molle: The lagoons are really interesting in that they open and close once a year, washing out the gravel to Chukchi Sea, and then they close up again. It's like an annual event in July with SW winds. The difference between the lagoons and sea are every fragile, very small, and they are soooo important for resource extraction. [This comment led to later suggestions of monitoring wind directions and their impact on lagoons and pollution.]*
- *Finn: What are they like in the winter?*
- *Sampson: They are frozen in the winter.*
- *Shults: There are fish that over-winter in the bigger lagoons. North Carolina has done some studies and found sculpin and other fish.*
- *Luecke: are they stratified?*
- *Shults: Talk to Charlie Lean, as he has taken measurements and has found some stratification.*
- *Hinzman: Permafrost there is not thick compared to GAAR. 50 m is not thick.*
- *Liebscher: When people think of eastern areas: 19,000 miles of streams. Lots of freshwater ecosystems, very vital in those areas.*

Dixon Landers presented a talk on the "Western Airborne Contaminants Assessment Project (WACAP)" and work being done in ARCN.

Discussion:

- *DeCicco: Do you find pollutants attached to the dust?*
- *Landers: It is essentially unknown, whatever it is coming across [the ocean]. Some people have looked and found these things. They aren't really being measured for pollutants by the meteorologists. China has a huge growing economy. There are also lots of other routes/directions pollutants are carried to Alaska. Every contaminant costs $800 to $1,000 per sample. It is very expensive! WACAP is looking at high elevation watersheds. Lakes are basically just big rain collectors. In a lot of high-altitude areas snow is the major input.*
- *Finn: Is anyone looking at the fluxes in and out of glaciers and snow?*
- *Landers: There was a great glacier core from Wyoming that shows the anthropogenic sources and show it very well.*
- *Sampson: What will you do once you know, and find these contaminants?*
- *Landers: For many of these things there is little that local managers can do, but the EPA has an office of international affairs. We will use this diplomatically.*
- *Andersen: Will you backtrack the pollution to its source, through its timing/location in the snowpack?*

- *Landers: That could be done, but we aren't sampling it that way. We are looking a total loading, not at individual events. We can't look at the short-term temporal scale right now. Ambler is a "primenet" set. It is low elevation. We will use it for comparison and interpretation of our results.*
- *Sanzone: How do you take into account the variability that is so high between lakes? How do you extrapolate?*
- *Landers: Not from this study, because we were just looking to see "is this contamination present in the parks?" We weren't out to try and answer that question. That is what we will be looking at over the coming day: how much scale would you like to examine, and how much can you afford?*
- *Hobbie: An AMAP book came out documenting what concentrations of contaminants were found/ listed, but no impact ecologically can be found.*
- *Landers: Many of the impacts of the contaminants are very subtle, and weren't measured. People need to think beyond just seeing dead fish. There are reproductive depression, sex changing, etc.*
- *Hughes: Central American fungicides coming up into Canada into lake trout, worrying about Native consumption.*
- *Landers: Toxophene has been found in high concentrations.*

Steve Young's Remarks:

(1) I've been doing things like this for 40 years, first traveled the NOAT in 1964. Since then one thing we think is that parks were imposed on some sort of pristine area that had no impacts in them. Nothing could be further from the truth: there was a huge amount of work going on in the Arctic. There were many reasons why these lands had to be protected quickly, the reasons were in many cases happening in response to something. If you compare areas in Siberia with areas here, you can see some of the horrible messes we've avoided. The big lakes had a ring of oil drums around them. These have been cleaned up now. There has been some success in the right direction now.

(2) A useful way to approach these things would be from the perspective of different scales. I'll start with time scales: Start with height of last glacial maximum. Moose in Arctic Alaska. In 1973, working in NOAT. Moose showing up in the late 1700s in the Brooks Range. Probably never been a significant element in the parks for the past 200 years. How do we know this? Good archaeological projects help with this. Still in the process of trying to figure out what the mammoth steppe is/was. One of the things to keep in mind is that you have an environment, and when you remove the mammoth you can't get that environment back without mammoths. When you look at arctic ecosystems you are dealing with a situation of just cycles where things advance and recede. Each time you go through a climatological change you end up with something new, with remnants of components and new components that come together as a new ecosystem. So we are talking about an ecosystem that is dynamic and constant changing, so we couldn't predict what will happen next even without anthropogenic effects. This throws a big monkey wrench into monitoring, so this is a challenge, and leads us to wonder about what our final goals CAN be.

(3) Human drivers: several things evident: these ecosystems have as far back as we go, humans have been part of the ecosystem, and continued through now. Each ethnicity with a different skills and ways to survive. For example, originally people were more terrestrially involved and less marine involved. Shows you how things have changed over time. It's important to look at the things left behind as clues to the environment.

Discussion:

- *Shults: I think caribou are much bigger driver than moose or muskox.*
- *Young: Yeah, so, I think "driver" might not be the best describer of this.*
- *Lawler: The idea that water cycle has changed with so much tied up in the glaciers.*
- *Young: On St. Lawrence Island there is a great spring, and one wonders if there was that thousands of years ago, to help understand human migration, utilization. Siberia has a steppe-like environment.*
- *Hinzman: We are looking at springs and their history. We can see where they were in the past over 8,000 years. They precipitate calcium carbonate, which shines on remote sensing, and we can look at.*
- *DeCicco: The subject of springs keeps coming up: they are critical to fish populations, providing some of the only over-wintering spots and spawning areas. In many places there isn't deep water.*
- *Young: Looking at long periods of time for the past, I think it is important to look at long periods of time into the future. While management decisions are often aimed at immediate threats, we shouldn't be blinded by this. So we need to look at a broader perspective of 50 to 100 years, more like that. There are a few things we CAN say. One is pressure on these lands is going to increase. Such as the proposed road systems for the NPRA. This is just one. Fifty or 100 years ago, these may not just be representations of these ecosystems; they very well may be islands within areas of much higher development, and they may be the only sources for baseline data, to explain what is/has happened. When scientists start finding out information that people don't want to hear, then scientists are thought not to know what they are talking about. So they couch their statements in terms of hypotheses and there seems to be disagreement. That same thing happen at all sorts of different scales. If you find out the caribou aren't doing well, because there is some sort of contamination, there are a lot of people who would just assume to not know that. This program is likely to generate controversies.*

Reports from first working group session:

I. Streams: (Nick Hughes presented for the group)

Nick highlighted 11 questions (see database output for details)

II. Lakes: (Chris Luecke presented for the group)

Chris highlighted eight questions (see database output for details)

Discussion:

- *Luecke: We came up with a lot of things similar to the streams group, which is good.*
- *Hobbie: A CD is coming out this fall summarizing work in the Arctic called, "Arctic Climate Impact Assessment."*
- *Finn: Weather is a major thing to monitor.*

III. Watersheds: (Breck Bowden presented for the group)

Breck highlighted eight questions (see database output for details)

Large Group General Discussion

The final discussion for Day 2 was to review the proposed questions themselves and see whether there were areas omitted by the question set.

Discussion:

- *Crosby: I've heard so far that these areas might not be adequately addressed by the questions: Unique ecological features, e.g., maar lakes, hot springs, springs, headwater streams, wetland vegetation complexes; and riparian areas.*
- *Larsen: The big gaps I see are the riparian areas and the wetlands because terrestrial and water each think it is the other group's responsibility.*
- *Sanzone: We had a wetlands group but some members of the technical committee wanted to dissolve it at the last minute.*
- *Neitlich: We never really mentioned it [wetlands] explicitly in our group.*
- *Young: I think we DID leave out things like wetlands, but if we didn't include it here we will need to include those areas in the terrestrial workshop.*
- *Luecke: In some way when I thought about stratification, I thought we would hope to include things such as these things: spring and nonspring areas, etc.*
- *Larsen: In a random sample design like in DENA, it is not happening; we are not getting to sample any of these unique features.*
- *Landers: I think that riparian areas would be assessed as we are doing river and stream ecosystems, that they can be accommodated in the sampling of those areas, in their sampling designs.*
- *Young: Except the unique features, all of these omitted/missing items are on the borderline between aquatic and terrestrial.*
- *Hinzman: It is important to remember that riparian work/riparian areas have been forgotten. They can change a lot, and it is hugely important for terrestrial mammals, and it falls between the cracks because it is too narrow for the scale of remote sensing to monitor well.*
- *Sanzone: And when you look at BELA it is all just one big wetland area.*
- *Oakley: Wetlands were left out of terrestrial and aquatic too.*
- *Liebscher: we need to make sure someone takes ownership.*
- *Landers: After you have your first discussion, and after you have a straw design, that you have a special workshop that deals with these special unique features. I think have a two or three day workshop just looking at that. For example, I don't think there is a good wetland monitoring plan in the whole United States that deals with this scale. I think they are complex issues.*
- *Landers: I think you keep them in mind and keep bringing them up, it is an iterative process.*
- *Bowden: I think when you do whatever stratification, it is critical to go back and find out if there are any key things that we missed?*

- *Landers: Once you stratify your system. You want to avoid pitfalls, like the watershed problem that happened in Denali. It would be nice if the Park Service summarizes and describes what other parks have done. We should try to make the best of the other attempts.*
- *Sanzone: If something fails I think it is also important to describe WHY it failed.*
- *Landers: Don't want to say they failed because of the watershed approach; the problem sounds that they stratified up front. Things changed, and they were stuck with a plan that was no longer valid.*
- *Young: The question of unique features: what qualifies? There are very different scales. Do we sample each spring? Is each one unique?*

April: one thing that is critical for a monitoring strategy is to remain flexible. How to be effective, given the uncertainties, that is why we are asking you what will work best regardless of the contingencies? So, we can perhaps summarize that our themes from yesterday, Day One, were:

1. Practicality: cost timeline, effective given uncertainty
2. Process monitoring vs. the change itself
3. Integration of past, present other systems
4. Importance of knowing the task

Discussion:

- *Bowden: We are working with apples and oranges—trying to compare questions developed the day before. Have a whole range from "what is the affect of climate change on freshwater?" to "How is ice thickness changing?" Ultimately this is a system, that we need to develop questions that Walter can take back to his village. Further, monitoring is an assessment of status and trends. Status is a time and place, cannot be inferred from somewhere else. Trends are changes in trends over time/space. If we stop there, we will not know why and how things change. If you want that you MUST have process info. Process CAN be transferred from one place to another, to explain status and trends. There needs to be an extremely judicious balance between intensive (at a minimum of sites) and extensive (at a bunch of sites) sampling.*
- *Luecke: Some of the questions are broad, some are very specific, i.e., how does climate change effect lake function?*
- *Sanzone: The ideal would be to have broad question with more narrow ones listed underneath.*
- *Underwood: It would be good if we recognize if we have the money to do extensive sampling. If so, that would help organize our questions in our groups.*
- *Oakley: If we had a single question that is an umbrella such as at Cape Cod, which is "It's all nutrients…". An overarching question would help.*

April: once we have our questions we can look back at them.

- *Young: Climate change is very important and we all recognize that. I think is important to find critical specific things that can be monitored. We are designing a system that takes into consideration what place we can measure, and what place will we probably need to measure in the future? We need to find*

our place here, but be aware what is going on at other parks, and nearby, so we CAN export/import the process information.

- *Hinzman: Cape Cod really has a clear vision of what their issues are. For these parks, it is climate change and anthropogenic impacts. Are there other categories in the next 30 to 50 years?*
- *Liebscher: I think that having all these experts here to get the maximum information captured from this session is the most valuable tool. We might have not gotten to do it all.*

April: So, are the main themes that status and trends have priority, and then process is slightly secondary? And are the overarching ideas climate change and anthropogenic changes?

- *Landers: To make it management relevant. We need to pick our indicators carefully. We can have lots of indicators for climate change. Selecting the cheaper, quicker metrics that will be broad and give you a good idea of what and how things are changing. Let's pick the cheap, quick ones to measure. Use Toolik and other places to help understand the processes, but we don't need to decide that all now.*
- *Sanzone: Amy and I have been struggling with what baseline data is out there. What do we wish we had? What is it that people will want to know in 20 to 30 years? What is that baseline stuff that would help in 20 to 30 years?*
- *Bowden: Before we put them into the database to discuss them, before making Jim try to put them into the database.*

How about status and change of landscape characteristics?

- *Hinzman: Need to talk about how is it now, and where is it going.*
- *Bowden: Trends don't provide process but it provides a framework. Those trends can be forward and backward.*
- *Hinzman: With process understanding we can project outside; the larger trends.*
- *Balser: Are changes in trends similar among watersheds in this region?*
- *Neitlich: I think it would be better not to have it watershed, to have it be landscape.*
- *Young: Could have it nested along the length of rivers, have a question about sources.*
- *Bowden: There is this unifying question about nutrients. And the question about sustainability of grasslands. Are the western arctic parks changing in response to climate change or anthropogenic change?*
- *Hinzman: What is the current landscape status and how is the ecosystem changing in response to a changing climate and anthropogenic factors?*
- *Lawler: How do we split up anthropogenic from climatic?*
- *Young: Climate change is will occur despite anthropogenic impacts. And things will occur without some identifiable reason.*
- *Lawler: Like western arctic caribou herd changing range distribution.*
- *Hinzman: Documenting change you can still incorporate all that.*

- *Bowden: Jim, you are trying to say how there is a difference between more distal influences and the within park subsistence or ATV use. Why don't we try to identify the key questions and come back to see if that helps? One key question: Is landcover changing? Vegetation?*
- *Hinzman: We need to include ponds and hydrologic cycles.*
- *Bowden: Is the hydrologic cycle changing, with sub questions of how is soil moisture changing, is precipitation changing?*
- *Hiinzman: Good for NSF changing. But is that a good way to look at it here?*
- *Neitlich: Water, geomorphological, biological questions is a good way to organize it.*
- *Bowden: Could have it set up Landcover, Hydrology, Geomorphology and have sub questions underneath.*
- *Lawler: Nine months of the year, it is frozen, does that occur in hydrology?*
- *Hinzman: That would go under hydrology. Are key components of the hydrology changing?*
- *Neitlich: What about including the biotic?*
- *Young: I feel that we are just measuring water chemistry...?*
- *Bowden: I feel as though our tool is mostly going to be a remote sensing tool. Even though it may not tell us much at some scales.*
- *Hinzman: We need to have a fifth question revolving around climate….*
- *Bowden: Is that a question in addition to our other questions? No, it fits in the other separate categories.*
- *Neitlich: what about human impacts?*
- *Bowden: Do we want to separate out the local and global anthropogenic impacts? I agree that we should include the cultural question: park on people and people on park; and do we lump or split direct impacts of visitor uses vs. what goes on in Siberia?*
- *Neitlich: I would say split, because of they are so different.*
- *Bowden: How would you monitor these differently?*
- *Hinzman: It would include atmospheric deposition, visitors, hunting, fishing.*
- *Neitlich: Maybe some of these can be taken up by other groups.*

So, summarizing, not in order of importance:

1. Are key components of the watercycle changing?
2. Are key components of the hydrography changing? (stream/lake physical "where things are")
3. Are key components of the biota changing?
4. (intentionally left blank…)
5. Is the human/freshwater interaction changing?
    - *Geomorpholgy data would go under hydrography*

- *By saying the key components we are targeting specific things, How is human use changing? What is current status/trajectory? The big guiding overarching question: How are the landscape characteristics of the Arctic parks changing due to climate change and anthropogenic change?*
- *Maybe we should look at how the climate is changing, and then look at how this then effects all these others:*

So we are back to:

1. How is climate changing?
2. How is water cycle changing?
3. Hydrography changing?
4. Biota changing?
5. Human-water interactions changing?

- Each of these five is a component and then our questions will come under each. That we can have additional sub questions:
  (1) How is climate changing in the artic parks? Under that goes temperature, precipitation, timing intensity i.e amplitudes, wind direction, speed (for lagoon opening and closing cycles, depositions, etc.) and soil temperature.
  (2) Are key components of the water cycle changing?
  (3) Are key components of the lake stream network changing? Under this goes connectedness of stream, permafrost, snowfields, glaciers, drainage patterns, bank erosion, fluvial geomorphology.
  The main drivers are climate and watercycle…. And as we get down the previous ones will be drivers as the others, and all influence the human interactions.
- Should we split this out by above and below the surface?
  - *Hinzman: How about thinking of these things as things we can measure as an indicator of how climate is changing? The most important surface energy balance factor is soil temperature.*
  - *Bowden: How about separating above and below ground?*
  - *Hinzman: why wouldn't landcover be soil and biota? So Biota: these would include landcover, soil characteristics, animals, and biodiversity. This is where the key connections/linkage would be made to the other workshops.*
  - *The whole thing is nested in each other, contributing to the next and back.*
  - *Human–water interactions; see this as key linkage to the streams/lakes/terrestrial groups where measurements would actually be made and impacts seen. We see anthropogenic inputs quantified here.*

Day 3 – Friday, 4 June 2004

The third and final day started with the working groups prioritizing their questions.

Reporting back:

LAKES:

- We lumped things by themes. The rest are mostly focused on anthropogenic effects.

WATERSHED:

- We had an overarching question with five sub themes. Each five has sub-questions that go together, and "How" is implied for each question.
- We avoided landcover as its own component due to the differences in what it really means.

STREAMS:

- We struck pretty strongly to status and trend
- Channel form and dynamics
- There may be just some things that stream ecologists care about more than terrestrial and vie versa; that's why it says specific.
- #6 is what we thought was missing, and is not really a monitoring component; better inventory, better habitat spawning, rearing, adult and growth and overwintering habitats.

Discussion:

- *Hobbie: One of the questions about the impact of global warming is the differing effects on physical aspects and chemical.*
- *Bowden: Have impact on the system by people, but then the impact on the people on the system.*
- *Landers: Why are you separating out global climate change from other anthropogenic stressors? Some people would like to delete climate change.*
- *Bowden: You could lump climate change as an anthropogenic driver. Climate change provides a context to interpret the results.*
- *Young: There are climate changes and drivers that are not anthropogenically caused.*

The workshop concluded by asking the participants for suggestions for future workshops and for improving the materials.

Discussion:

- *Landers: I thought the computers were constraining, but efficient and was a good way to go. Get projectors for each of them.*
- *Bowden: Should be complemented on a good workbook. Don't worry about incorporating changing things midstream. I understand the reasons for using the computer worksheet. But BE SURE that everyone is on the same in terms of semantics: what is a component and what is a driver.*
- *Landers: I'm concerned about the definitions of what a lake really is. It is important to think of your definitions and communicate them. Need these maps of where these things are explicitly. If you don't have map coverage of similar quality across the whole area…. Need to get those resources assembled and well thought out to help get the next stage ready. It this sort of simple thing that can derail efforts.*
- *Hinzman: I thought the notebook was terrific, but send it out earlier. I didn't have time to read it all. Will the literature review be done? It would really useful to use.*
- *Balser: Another thing that would be useful is a glossary of terms and acronyms.*
- *Sanzone: Are questions the best way to frame it?*
- *Young: I think the questions worked fine, but I think the flexibility was very important, and this was a great group, but there is no guarantee that the next group will work out that way.*
- *Oakley: I would like to have been walked through the models you had. A start of what we know now?*
- *Bowden: What was in here was the framework for a conceptual model, not the models themselves. To what degree do you trade off to try and go beyond the framework and actually talk about conceptual models.*
- *Bowden: We got excited in my group when things started showing relationships and come up with a basic flow model.*
- *Landers: It might be good for the next generation of this group to make up straw models to discuss.*
- *Leucke: Maybe you could have that be a next question in the worksheet?*
- *Sanzone: Could I have that be a post-meeting query?*
- *Bowden: There is a way of having a group with a mediated group model…. That is a really powerful method. Yes, you can ask us.*
- *Sanzone: Any more thoughts for me, keep this in mind for monitoring/designing/big picture*
- *Bowden: I'm a little disappointed that Walter and Pollock aren't here. We really need to further involve the native population. But it is critical.*
- *Heinlein: The fact that they received an invite and came at all is good.*
- *Underwood: FRA one sheet informational mailing to everyone in a village telling them what we did.*
- *Heinlein: A nice poster works great too.*
- *Finn: We need to be careful to not just be "informative" rather than seeking input, can't just show up and tell them what we are doing. You have to go to them. You can't just send out questionnaires. Go out to some of these villages.*

- *Liebscher: The invitation was extended. The resident zone communities, Walter and Pollock are good for distribution of information. The SRC's might invite you out for a meeting.*
- *Shults: The quest for cultural knowledge is separate from political considerations.*
- *Hughes: Take your flow chart of the monitoring design political process and add the Native locals in as a more explicit part of the process.*
- *Larsen: I like the idea of having them being truly engaged, actively involved, doing this to integrate.*
- *April: maybe doing it through the schools?*
- *Shults: I'm not thinking that people are going to be all that excited about being involved.*